

SECTION 34 42 24

TRAIN CONTROL ROOM EQUIPMENT

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Vital relays
- B. Non-vital relays
- C. Timer equipment
- D. DC power supplies
- E. Frequency converters
- F. Signal transformers
- G. Ground detectors
- H. Lightning protection
- I. Filters

1.02 MEASUREMENT AND PAYMENT

- A. General: Train control room equipment, as specified herein, will not be measured separately for payment but will be paid for as part of the Contract lump sum price for Automatic Train Control System Work as indicated in the Bid Schedule of the Bid Form.

1.03 REFERENCES

- A. American Railway Engineering and Maintenance-of-Way Association (AREMA)
 - 1. AREMA Signal Manual

1.04 SUBMITTALS

- A. General: Refer to Section 01 33 00, Submittal Procedures, and Section 01 33 23, Shop Drawings, Product Data, and Samples, for submittal requirements and procedures.
- B. Submit product information and catalog cuts of equipment and devices specified herein.
- C. Submit samples of vital and non-vital relays upon request by the District.

PART 2 - PRODUCTS

2.01 VITAL RELAYS

- A. General: Vital relays shall include biased-neutral relays and AC relays. Vital relays shall conform to AREMA specifications. Product information for all vital relays shall be submitted for approval.
1. Shipping: Vital relays shall be shipped separately from the equipment racks in which they are to be mounted.
 2. Plug-In Type: Vital relays shall be of the plug-in type. Relays of the same type shall be uniform in design and contact assembly. Relays shall be furnished with transparent dustcovers of nonflammable material. A machine-printed laminated or other permanent type name tag shall be fixed mechanically without glue on each relay cover. The name tag shall be removable and replaceable, but shall not vibrate loose under normal operating conditions.
 3. Relay Mounting: Relays shall be mounted in cabinets only after cabinets have been installed. As relays are mounted, record relay serial numbers corresponding to cabinet location. Relays shall be secured against vibrations. Vital relay plugboards shall be front-frame mounted. Vital relay plugboards shall be secured with bolts, lock washers, and nuts.
 4. Vital Relay Plugboards: Plugboards for plug-in vital relays shall be provided with removable contacts. Wires shall be attached to these removable contacts. The plugboard shall be designed so that the removable contact shall have a direct connection with the relay coil and the relay contact prongs. The plugboards shall conform to AREMA Signal Manual, Part 6.2.1. The wiring to each removable plugboard contact shall carry a District approved tag indicating the relay contact or coil number assigned to the wire. The back of the plugboards shall be tagged to indicate the nomenclature of the relay for which the plugboard is wired. The contact numbering system shall be uniform for each type of relay used.
 5. Keying: The relays and plugboards shall be mechanically keyed to prevent relays of the incorrect style, contact arrangements, or operating characteristics from being inserted on any given plugboard. Keying on relays and plugboards shall be the manufacturer's standard keying.
 6. Surge Suppression: Surge suppression for all vital DC relay coils shall be provided. A transient sensing device, such as a transorb, shall be connected in parallel with each relay coil, and shall be built into the relay or its plugboard, or shall be mounted to the back of the plugboard in a manner that has been approved by the District.
 7. Contact Resistance: The contact resistance of vital relays shall meet the requirements of the AREMA Signal Manual, Part 6.2.1, Section L, Subsections 8 and 9.
 8. Spare Contacts: Each vital relay provided shall have a minimum of one spare dependent front-back contact, or one spare independent front and one spare independent back contact, or one spare dependent normal-reverse contact except as indicated below:
 - a. Where a single repeater relay is used, either the repeater relay or the primary relay shall have a minimum of one spare dependent front-back, or one spare independent front and one spare independent back contact, or one spare dependent normal-reverse contact.
 - b. Where more than one repeater relay is used, the final repeater relay and the primary relay shall have a minimum of one spare dependent front-back contact, or one spare independent front and one spare independent back contact, or one spare dependent

normal-reverse contact. These spare contact requirements shall be met throughout the installation and test period and at the conclusion of any and all field corrections.

9. Nominal Operating Voltage: Vital DC relays shall operate at a nominal voltage in the range of 12 to 28 volts.
- B. Biased-Neutral Relays: Vital biased-neutral relays shall meet the requirements of the AREMA Signal Manual, Part 6.2.1 and Part 6.1.5, Section G, subsections 7, 8, and 9.
1. Contacts: Each vital biased-neutral relay shall have a minimum of four independent front contacts, two dependent front-back contacts, and two independent back contacts unless otherwise approved by the District.
 2. All front contacts shall be silver-to-metalized carbon contacts. Metal-to-metal contacts, front and back, may be allowed for limited applications only if specifically approved by the District.
- C. Switch Operating Relays or Biased Neutral Controller: One normal and one reverse switch operating relay, or equivalent, shall be provided for each switch-and-lock movement. Switch operating relays used to control the polarity of the operating current for switch-and-lock movements shall meet the same requirements as specified herein above except as follows:
1. Contacts. Each switch operating relay shall have a minimum of either two dependent front-back contacts or two independent front contacts and two independent back contacts. Each contact shall be equipped with a magnetic blow-out feature to effectively interrupt high currents and minimize contact wear. Each contact shall be capable of interrupting the normal switch-and-lock movement operating current.
- D. Switch Overload Relay: One switch overload relay shall be provided for each switch-and-lock movement. Each switch overload relay shall be equipped with a timer which will cause the relay to energize 8 seconds after a switch position change is requested should the switch fail to achieve correspondence with the requested position. Upon expiration of the 8 second timer, the switch overload relay shall de-energize the active contactor. Upon request of the switch to the alternate position, the overload relay shall release allowing operation of the alternate contactor and simultaneously the timer will reset and initiate the timing cycle to verify completion of the alternate switch position request.
- E. Vital AC Relays: Vital AC relays shall be two-element, 100 Hz vane-type induction relays. Vital AC relays shall be capable of operating continuously and successfully without resultant damage with a minimum voltage range of 100 volts to 135 volts, inclusive, applied to the local winding and with a minimum voltage range of three volts to eight volts, inclusive, applied to the control winding. The minimum pick-up current shall be 0.28 amps applied to the control winding.
1. Contacts: Each vital AC relay shall have a minimum of two independent front contacts and two independent back contacts, unless otherwise approved by the District. Each front contact shall be of the silver-to-metalized carbon type.
 2. AREMA Standards: Vital AC relays shall meet the requirements established by AREMA Signal Manual, Part 6.1.35, with the exception that these relays shall be plug-in type; and, therefore, shall not have a screened breather and shall not be equipped with binding posts. These relays shall also meet the requirements established in Section 7, Design, of AREMA

Signal Manual, Part 6.2.1, Section G.

2.02 NON-VITAL RELAYS AND TIMER EQUIPMENT

A. General: Non-vital relays and timer equipment are devices used in train control system circuitry not considered to be vital to passenger or train safety. Non-vital relays and timer equipment required to provide a complete and working ATC system shall be furnished. Non-vital relays shall include, if needed, general purpose interfacing relays and heavy duty interfacing relays. Product information for all non-vital relays and timer equipment shall be submitted for approval.

1. Shipping

- a. Non-vital heavy duty interfacing relays may be mounted and shipped in the equipment racks or cabinets in which they are to be used.
- b. Non-vital general purpose interfacing relays shall be mounted and shipped on the printed circuit cards on which they are to be used.

2. Type: Non-vital logic relays (normal acting and magnetic stick) and non-vital heavy duty interfacing relays shall be of the plug-in type. Relays of the same type shall be uniform in design and contact assembly.

3. Mounting: Non-vital general purpose interfacing relays shall be mounted on plug-in type printed circuit cards and shall be soldered to conductors on the cards. Non-vital relays shall be mechanically secured to the plugboard.

4. Name Tags: A machine printed permanent relay name tag shall be mounted on each relay. The relay name tag shall be easily replaceable but shall not come off due to vibration.

5. Printed Circuit Cards:

- a. Each printed circuit card on which non-vital, general purpose interfacing relays are mounted shall have one LED indicator light mounted along the front edge of the card for each relay in such a manner that the lights can be readily viewed for troubleshooting. The indicating light shall be operated by a contact on the relay so that it will be illuminated whenever the relay is picked up. Each indicating light shall be identified, both on the printed circuit card and on the transparent front plate of the card cage, with the name of the relay it indicates.
- b. Groups of printed circuit cards on which non-vital, general purpose interfacing relays are mounted shall be installed in metal printed circuit card cages that have transparent front plates of nonflammable material. The design of the card cage shall permit viewing each relay indicator light without disassembly or other mechanical manipulation.

B. Non-vital, General Purpose Interfacing Relays: Non-vital, general purpose interfacing relays shall be reed relays or crystal case relays, either type with hermetically-sealed contacts and epoxy-encapsulated coils. These relays shall be mounted on printed circuit cards as indicated herein. Non-vital general purpose interfacing relays shall be DC relays with a nominal operating voltage of from 18 volts to 28 volts. These relays shall pick up with 12 volts or more applied to their operating circuit and shall drop out when this voltage is removed. These relays shall be capable of

operating continuously with up to six volts above nominal operating voltage applied to their operating circuit. Non-vital, general purpose interfacing relays shall pick up in less than 50 ms when energized with 12 volts or more and shall drop out in less than 50 ms when de-energized from nominal voltage. These times shall be measured from a front contact closure or opening from the instant the switch applying the voltage closes and from the instant the switch removing the voltage opens.

1. Standardization: All non-vital general purpose interfacing relays shall be identical. All printed circuit card assemblies containing non-vital general purpose interfacing relays shall be identical.
 2. Contacts: Each non-vital, general purpose interfacing relay shall be equipped with a minimum of two front contacts, one of which shall be used for an indication light circuit. Each contact shall be metal-to-metal and shall be capable of carrying and breaking a load with the following characteristics:
 3. Contact Resistance: Each contact shall be capable of breaking a resistive load with these characteristics, or an inductive load suppressed so that at no time during steady state or switching conditions shall the load exceed these characteristics. This operation shall be performed at least 1.5 million times without the contact resistance, measured at 10 ma in a three-volt DC circuit, exceeding three ohms.
 - a. Non-vital general purpose interfacing relays shall be capable of the electrical operation indicated herein above after 10 million mechanical cycles without an electrical load on their contacts.
 - b. Under all conditions, the minimum open contact resistance shall be 50 megohms at 400 volts DC, and the maximum duration of contact bounce shall be five ms.
 4. Surge Suppression: Surge suppression for non-vital general purpose interfacing relay coils shall be built into the printed circuit card on which the relays are mounted. This suppression shall prevent the load presented to a contact controlling each relay coil from exceeding the following values during steady state or switching conditions:
 - a. Maximum volt-amp load: 15 VA.
 - b. Maximum load current: 1 amp.
 - c. Maximum switched voltage: 250 volts.
- C. Non-vital Heavy Duty Interfacing Relays: Non-vital heavy duty interfacing relays shall be plug-in DC neutral relays with a nominal operating voltage of from 18 volts to 28 volts. These relays shall pick up with 12 volts or more applied to their operating circuit, and shall drop out when this voltage decreases below 12 volts. These relays shall be capable of operating continuously with up to at least six volts above nominal operating voltage applied to their operating circuit. Non-vital, heavy duty interfacing relays shall pick up in less than 35 ms when energized with nominal voltage, and shall drop out when de-energized from nominal voltage in less than 60 ms. These times shall be measured as a front contact closure or opening from the instant the switch applying the voltage closes and from the instant the switch removing the voltage opens.

1. Contacts: Each non-vital heavy duty interfacing relay shall be equipped with a minimum of two front-back contacts. Each contact shall be metal-to-metal and shall be capable of carrying and breaking a resistive or an inductive load, which does not exceed the following characteristics, one million times. The contact resistance, measured at five amps, shall not exceed one ohm for this operation:
 - a. Maximum continuous volt-amp load: 200 VA;
 - b. Maximum volt-amp load while relay contact is opening (transient due to inductive surge): 300 VA;
 - c. Maximum instantaneous load current: 5 amps;
 - d. Maximum continuous load current: 5 amps;
 - e. Maximum instantaneous switched voltage: 100 volts DC.
2. Each contact shall also be capable of carrying and breaking a resistive load or an inductive load, which does not exceed the following characteristics, five million times. The contact resistance, measured at 0.5 amp, shall not exceed one ohm for this operation:
 - a. Maximum continuous volt-amp load: 50 VA;
 - b. Maximum volt-amp load while relay contact is opening (transient due to inductive surge): 90 VA;
 - c. Maximum instantaneous load current: 1.25 amps;
 - d. Maximum continuous load current: 1.25 amps;
 - e. Maximum instantaneous switched voltage: 100 volts.
3. Surge Suppression: Surge suppression shall be provided for non-vital, heavy-duty interfacing relay coils.

2.03 DC POWER SUPPLIES:

- A. General: Direct current power supplies shall meet the following requirements. Product information for all DC Power Supplies shall be submitted to the District for approval.
 1. Operate satisfactorily in both single and parallel (continuous current sharing) modes;
 2. Input voltage rating shall be for connection to a 120 volts ac, single-phase, 60 Hz ungrounded power system;
 3. Outputs shall be isolated from ground;
 4. Additional requirements:
 - a. Semiconductors shall be silicon type with JEDEC numbers;

- b. Transformers shall not emit audible noise in excess of 75 db, referenced to 0.0002 dynes/cm² at a distance of 2 feet, at rated voltage and current;
 - c. For each type supply, the equipment and ratings shall be identical throughout the system, and the equipment shall be interchangeable;
 - d. Output voltage shall be nominal plus/minus 5 percent with input variations from 105 to 130 VAC at a temperature of 40 degrees C;
 - e. Output voltage from zero to full load shall not vary more than 3 percent within a temperature range of 0 to 50 degrees C;
 - f. Provide current limiting and adjustable overvoltage protection. Current limiting shall limit output current to no more than 130 percent of the 40 degrees C rated current rating;
 - g. Provide an adjustable undervoltage detection circuit which shall de-energize a relay with form-C contacts when the output voltage of the power supply falls to a set value. The undervoltage circuits shall reset automatically when the undervoltage condition is removed. The relay outputs shall alarm as indicated;
 - h. Power supplies shall utilize a diode auctioneering form of loadsharing. Both normal and reserve power supplies shall be on-line at all times with the normal power supply providing 50 percent of the load demands and the reserve power supply providing the remaining 50 percent;
 - i. Both the normal and the reserve power supply shall be designed and rated for continuous operation at a minimum of 125 percent of the full (normal plus reserve) load; and,
 - j. Power supply output ripple shall not exceed one percent.
- 5. Power supplies shall be protected as indicated; and,
 - 6. Power supplies shall be clearly and permanently labeled with the manufacturer's name, serial number, part or model number, and input and output rating.

2.04 FREQUENCY CONVERTERS

A. General: Solid state frequency converters shall meet the following requirements:

- 1. The frequency converter shall operate from a 120VAC, 60-Hz service and shall have an output of 120VAC at 100 Hz.
- 2. The converter shall be kept in phase with a phase lock circuit.
- 3. Frequency converters shall be used in pairs. One converter shall normally supply signal power unless it fails, at which time the redundant converter shall automatically go on-line. Contacts shall be provided to interface to alarm circuitry to indicate when a unit fails, or when a problem occurs affecting the phase lock loop reference signal. Detectable failures shall include:

- a. Overvoltage/undervoltage on output;
 - b. Phase relation to sync greater than 10 degrees;
 - c. Loss of synchronization signal.
4. Each frequency converter shall be sized to continuously furnish a minimum of 150 percent of the calculated maximum power load for its related location or zone. If the calculated load underestimates the worst case actual load measured during testing and operations, the undersized converters shall be replaced with properly sized converters at no additional cost to the District.
 5. Frequency converter equipment shall be of the solid-state, AC power source, synthesized sine wave type.
 6. Converters shall meet these minimum requirements:
 - a. Load power factor: 0.8 lead or 0.7 lag at rated output;
 - b. Efficiency: 70 percent minimum;
 - c. Voltage regulation: Plus or minus 1% with line fluctuations of plus or minus 10% from no load to full load;
 - d. Frequency stability: 2% minimum;
 - e. Harmonic distortion: 4% maximum at any load/input specified herein;
 - f. Meters: Panel voltmeter, ammeter, and frequency meter with 2% minimum accuracy;
 - g. Output power: Single-phase, two-wire, isolated output adjustable from 105 to 130 volts AC at operating frequency;
 - h. Protection: Provide input and output circuit protection as indicated.
 7. Where more than one converter pair is provided at a given location, one converter pair shall be designated as the master, and all other converter pairs shall be synchronized to the master.
 8. Converters shall be designed to allow replacement by one maintenance technician.
 9. The design of the frequency converter systems shall be submitted for approval.

2.05 SIGNAL TRANSFORMERS

- A. General: The Contractor shall compute the sizes of signal transformers required to feed the loads for the equipment. The transformers shall be air cooled, dry type, and shall be in accordance with AREMA Signal Manual Part 14.2.10 for single phase transformers. Product information for signal transformers shall be submitted to the District for approval.
 - 1. Taps: Primary and secondary taps of all power transformers, except track transformers, shall be brought to a terminal board mounted inside the transformer case. Power transformer secondary windings shall have a minimum of two taps above and two taps below the computed voltage and shall have a 10 percent tap/change ratio. Primary windings shall be equipped with taps to accommodate a 20% variance from the supply voltage. A lead for each secondary winding connection and two leads for the primary winding shall be brought out of the transformer case through wall bushings. Primary winding taps shall be provided on terminal boards with bolted jumpers or straps for tap changing.
 - 2. Isolation: Means shall be provided to isolate each transformer for maintenance without interruption in the primary ATC power supply.

2.06 GROUND DETECTORS

- A. General: Ground detectors for ac and dc buses shall be located on or in the vicinity of the power racks. Product information on ground detectors shall be submitted to the District for approval.
 - 1. Ground detectors shall have the sensitivity to detect a minimum ground leakage resistance from either ac or dc supply bus. The ground detectors shall be rack mounted in the train control rooms and train control houses. The level of ground detection shall be as approved by the District.
 - 2. Each DC ground detector unit shall be provided with three indications and a test control. Two indicators, one each for positive and negative, shall indicate the presence of a ground. The third indicator shall indicate that the ground detector is operating properly and no grounds are present. Separate DC ground detectors shall be provided for each DC voltage supply.
 - 3. One AC ground detector shall be provided for each ungrounded AC power supply in each train control room and train control house. Each AC ground detector shall have two indications and a test control. One indicator shall indicate the presence of a ground. The other shall indicate that the ground detector is operating and no grounds are present.
 - 4. Ground detectors at a TCR shall be provided with alarm contacts for connection to a summary alarm to the SCADA system.

2.07 LIGHTNING PROTECTION

- A. Provide lightning arresters and other circuit protection devices necessary to protect wayside equipment from damage and false operation due to lightning. The lightning arresters shall comply with AREMA Signal Manual, Part 11.1.10, for lightning protection. Product information for all types of lightning protection shall be submitted to the District for approval.
- B. Track circuits entering or leaving the train control equipment room/house shall be protected by

gas-type lightning arresters, or District-approved equivalent, located in the train control equipment room/house.

2.08 FILTERS

- A. General: Filters for train detection and TWC reception circuits shall be designed for narrow passband and sharp cut-off characteristics. Filters used in fail-safe circuits shall be designed to prevent undesired signals from passing through the filter at levels that could cause unsafe conditions, even in the event of a component failure within the filter.
1. Half power points (3db) shall be a maximum ± 13 Hz from the center frequency.
 2. Ripple within the passband shall not exceed 1db.
 3. Filter output shall be down 60db at maximum ± 75 Hz from the center frequency.

PART 3 - EXECUTION

Not used

END OF SECTION 34 42 24